Technologies and Trends for Residential Smart Grid

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DOE EERE Residential Energy Efficiency Meeting
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Agenda

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- Bringing the Smart Grid Home
  - Smart Meters ≠ Smart Grid
  - From Asset-Based to Operational Efficiency
  - Home Automation: Convenience vs. Energy Management
- Tendril Approach to Home Energy Management
  - Home Energy Management Landscape
  - Platform
  - Applications and Devices
  - Ecosystem
  - Successes
- Research Areas
  - Demand response
  - Boosting operational efficiency
  - Social marketing approaches

What is the Smart Grid?

Beyond Smart Meters

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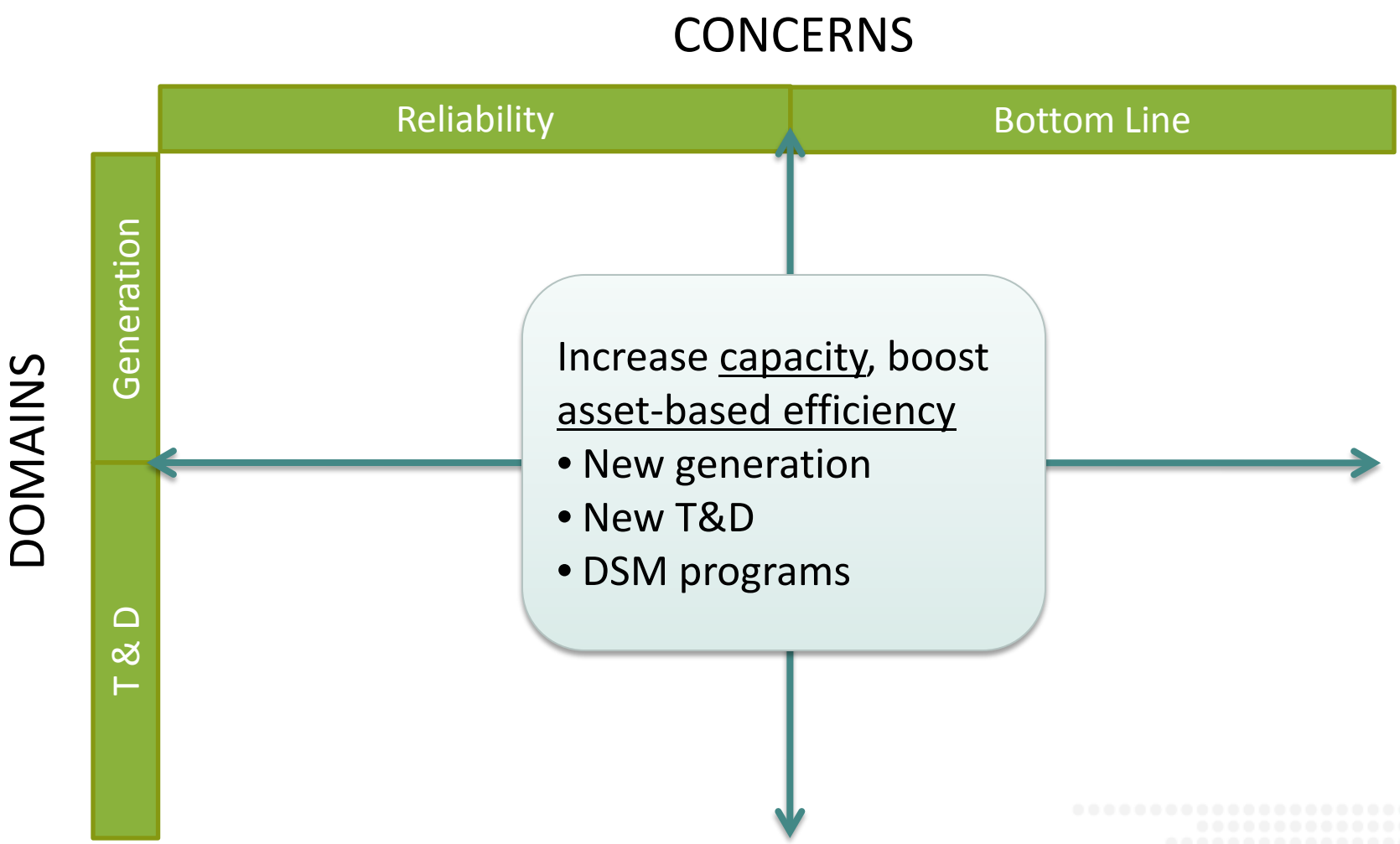
Smart Grid = Energy Information

- AMI (smart meters)
- AMR (drive-by meters)
- Cellular
- Wireless
- Broadband

Utility Outlook

Asset-Based Paradigm



Utility Outlook

Smart Grid: the Information-Based Paradigm

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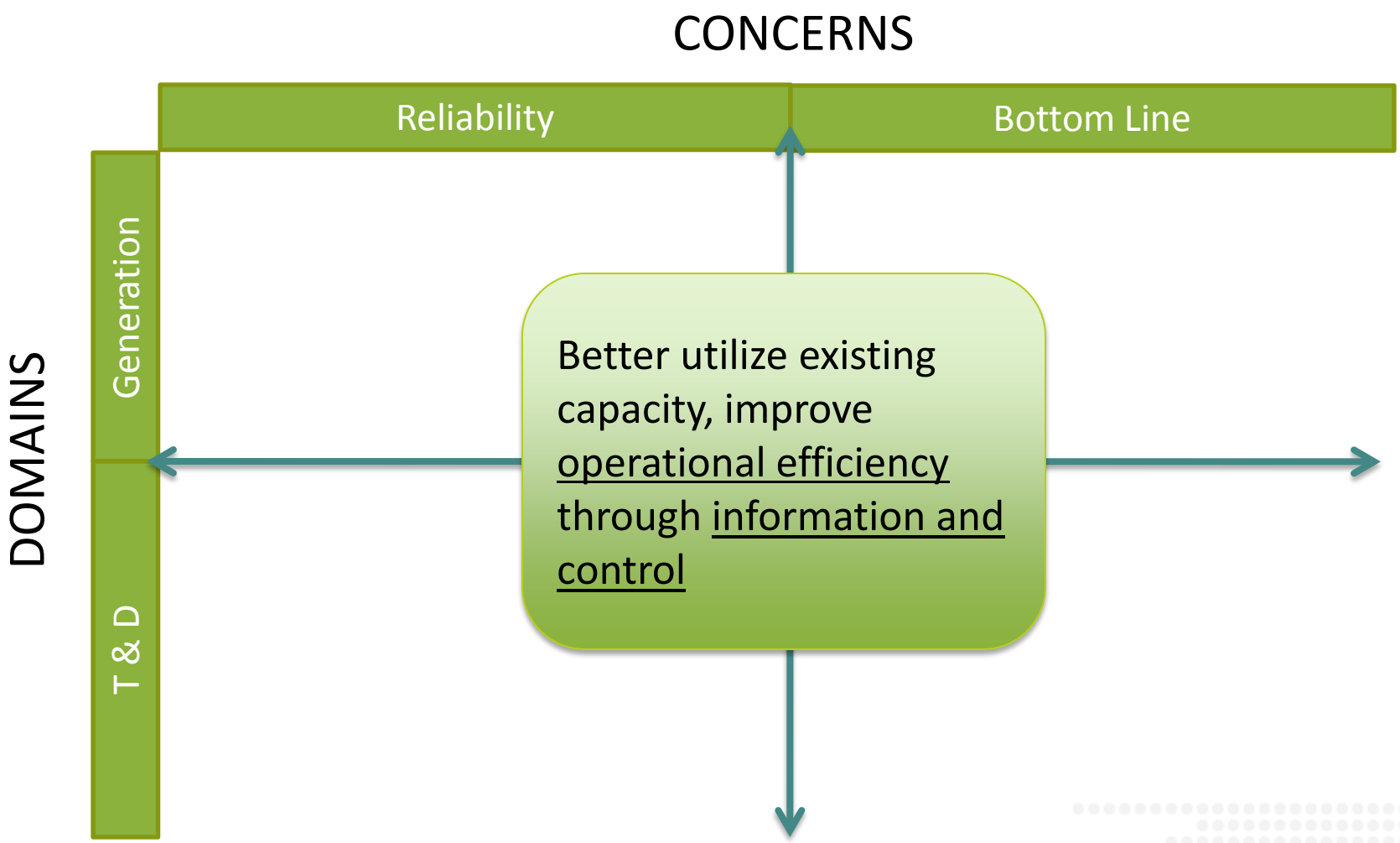

FERC Report: Demand Response Potential

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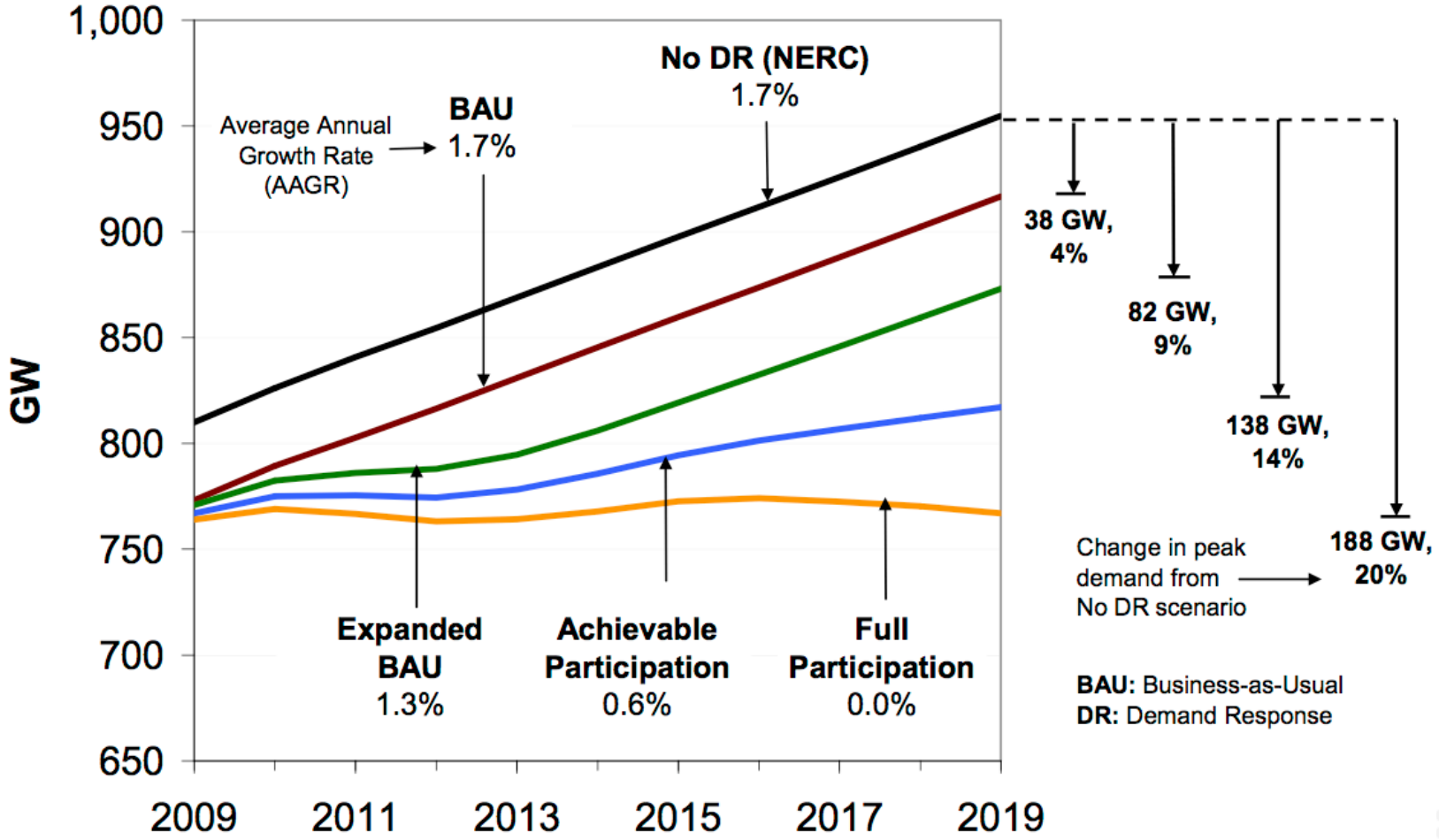
Figure 1: U.S. Summer Peak Demand Forecast by Scenario



source: FERC *Assessment of Demand Response & Advanced Metering* 2009
assumptions: smart meters, dynamic pricing default, enabling technologies

The Power of the Consumer

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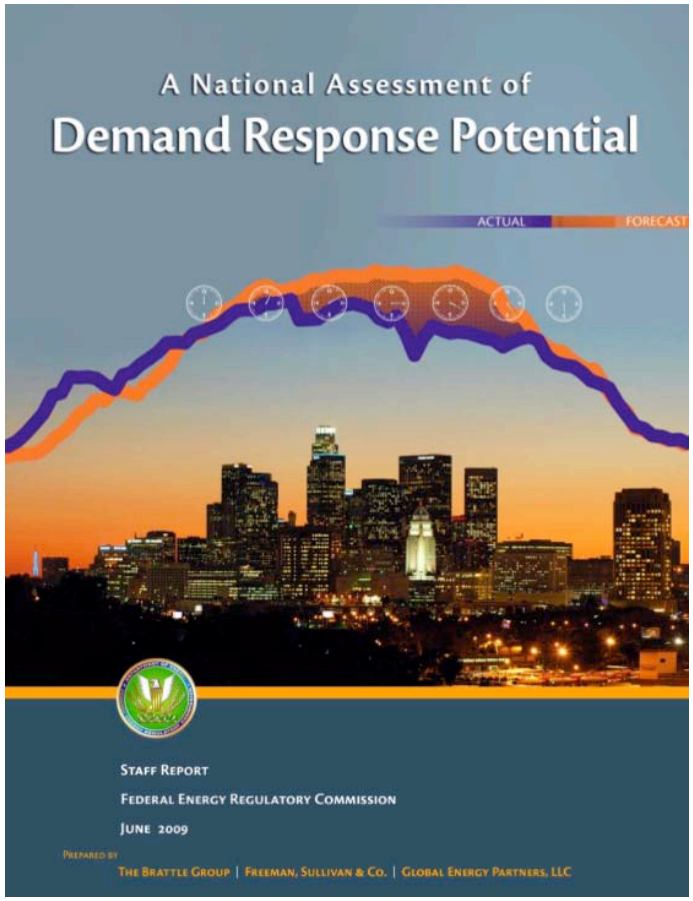

"It is the residential class that represents the most untapped potential for demand response."

source: FERC *Assessment of Demand Response & Advanced Metering* 2009, p.29

Home Energy Management Landscape

From Convenience to Energy Management

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Convenience

Home Energy Management

- Energy Awareness
- Load Control and Demand Response
- Home Energy Management Ecosystem

Google powermeter

Control 4

Microsoft hohm beta

OPEN PEAK

eMeter

EcoFactor

OPOWER

comverge

GRIDPOINT®

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Tendril At A Glance

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- Company Overview
  - Founded in 2004
  - Venture-backed with > $50M raised to date
  - Headquartered in Boulder, Colorado
  - ~ 90 Employees

The Tendril Platform

Linking Smart Grid Utilities and Their Customers

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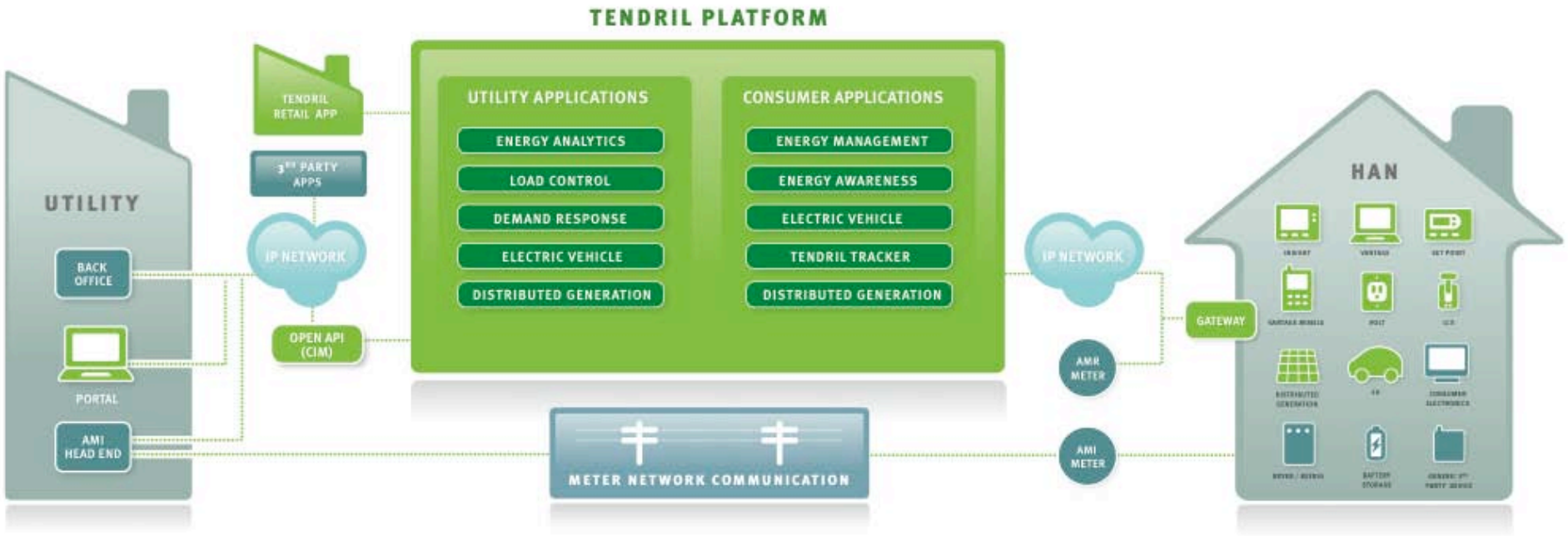

1. Open software platform
2. Utility application suite
3. Family of in-home devices and applications

Consumer-Facing Smart Grid Applications

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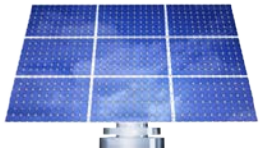

Distributed Generation	Effectively integrate distributed generation assets
Electric Vehicle	Coordinate and optimize the charging of electric vehicles
Energy Management	Enhanced insight and control of home energy use
Energy Awareness	Feature-rich in-home information portal for energy use insight
Tendril Tracker	Low-cost participation with no AMI and minimal in-home hardware

Tendril Networked Devices

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DISPLAY

Vision: Full-featured, engaging info and control

Insight: Everyday info and control appliance

Vantage and Tracker: Web-based info and control portals

MONITOR AND CONTROL

Setpoint: Tendril's smart thermostat

Volt: Tendril's smart outlet

LCS: Hard switch for legacy loads

NETWORK

Transport: broadband gateway device

Translate: Communicate with legacy AMR meters

Relay: Extend HANs

The Growing Tendril Ecosystem

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Industry partners

Landis+Gyr manage energy better

Itron

EnTek

current

SILVERSPRING NETWORKS

better place

…for integrated utility solutions

Consumer partners

GE

intel

Fat Spaniel® TECHNOLOGIES

Energate

DMN3 ONLINE | OFFLINE | OPTIMIZATION

…for compelling in-home experience

Summer 2010 Projects

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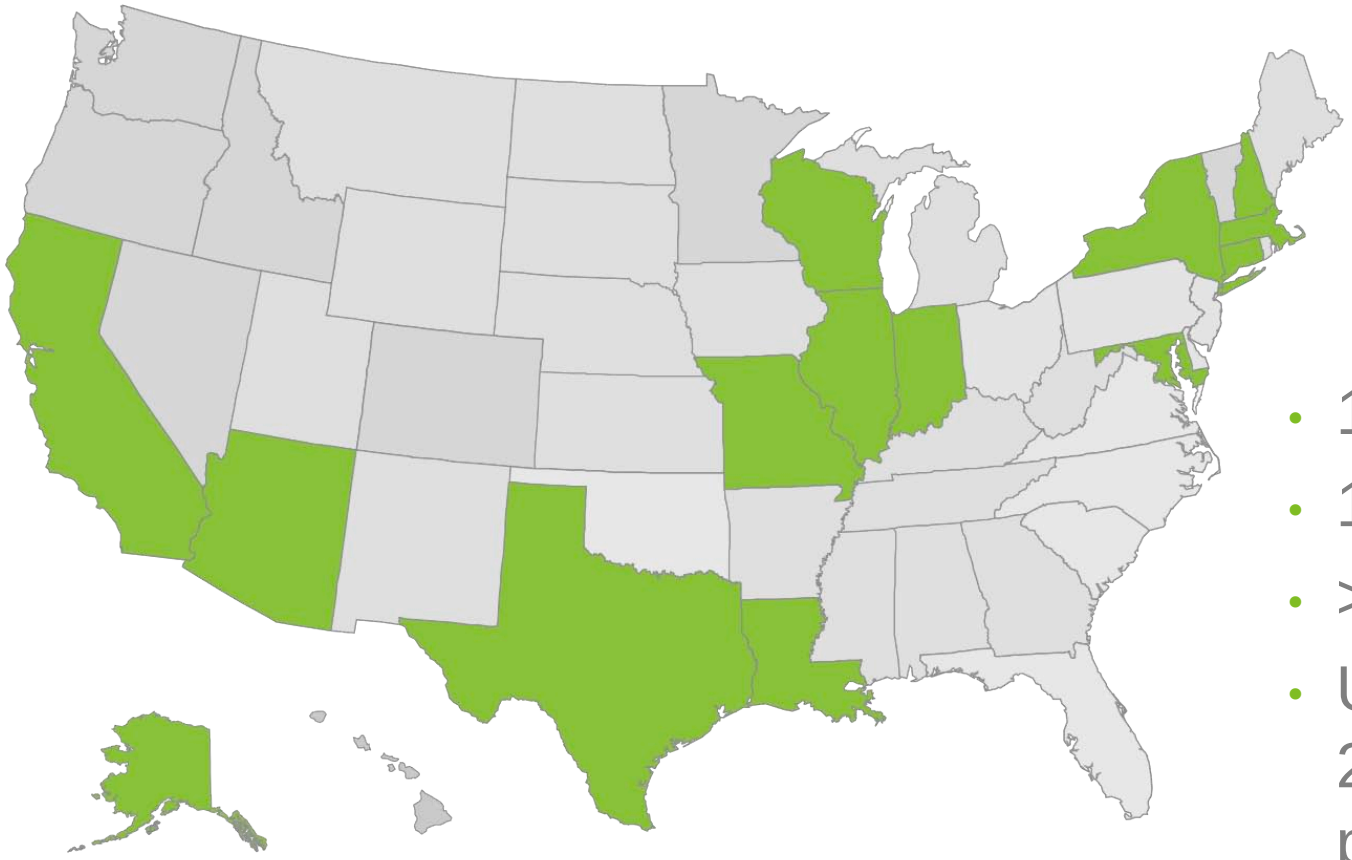

- 14 states
- 17 projects
- > 10k homes
- Utilities represent 25% of US population

Residential Smart Grid Research

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- Residential smart grid technologies a perfect match for BAP
  - Today's solutions scalable from low-cost portals to complete home energy management systems
  - Combined home performance monitoring/data logging and home energy management functionality
  - Facilitates innovative neighborhood- and community-scale approach
- Three core research areas:
  1. Improving operational efficiency
  2. Demand response and load control
  3. Community-scale approaches

Improving Operational Efficiency

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- Behavioral
  - How much energy can we save by engaging homeowners with energy usage and cost information?
  - How readily will homeowners implement energy tips?
- Technical
  - How much of the retrofit/new construction opportunity is comprised by residential home energy management and associated operational efficiency improvements?
  - What level of technical sophistication do we need for optimized controls? (Learning, model-based, etc.)
  - How can we provide targeted, accurate energy tips to consumers using minimally invasive techniques (remote audit)?
  - Can we intelligently disaggregate home energy use data without the need for extensive sub-metering?

Google powermeter
Microsoft® hohm™ beta
BELKIN

Demand Response and Load Control

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- Behavioral
  - What are typical participation rates in residential DR events?
  - What causes homeowners to opt out of various DR events?
- Technical
  - What are *realistic* demand reduction potentials for various smart appliances?
  - Do advanced control techniques (e.g. model-predictive control) improve demand response under various rate structures?
  - To what extent can thermal storage in residential buildings be used to level loads and increase renewables penetration?
  - What are the limits to a home's load elasticity?
  - How do we coordinate and integrate EV charging and DG at the community scale?

Community Approaches and Social Marketing

Harnessing Competition for Operational Efficiency

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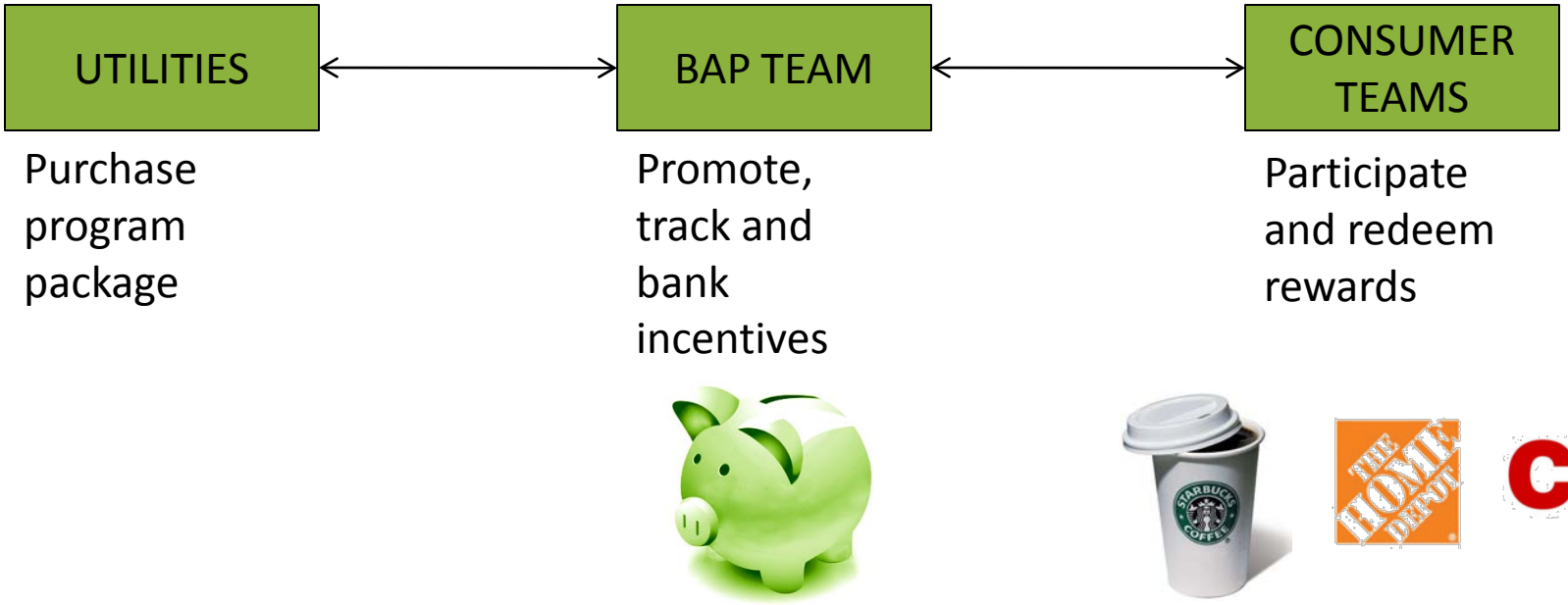
- Are consumers motivated by knowing their neighbor's energy use?
- Community-level competitions: Cost-effective? Participation?



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Pilots Indicate Smart Grid Devices are Improving Peak Reduction

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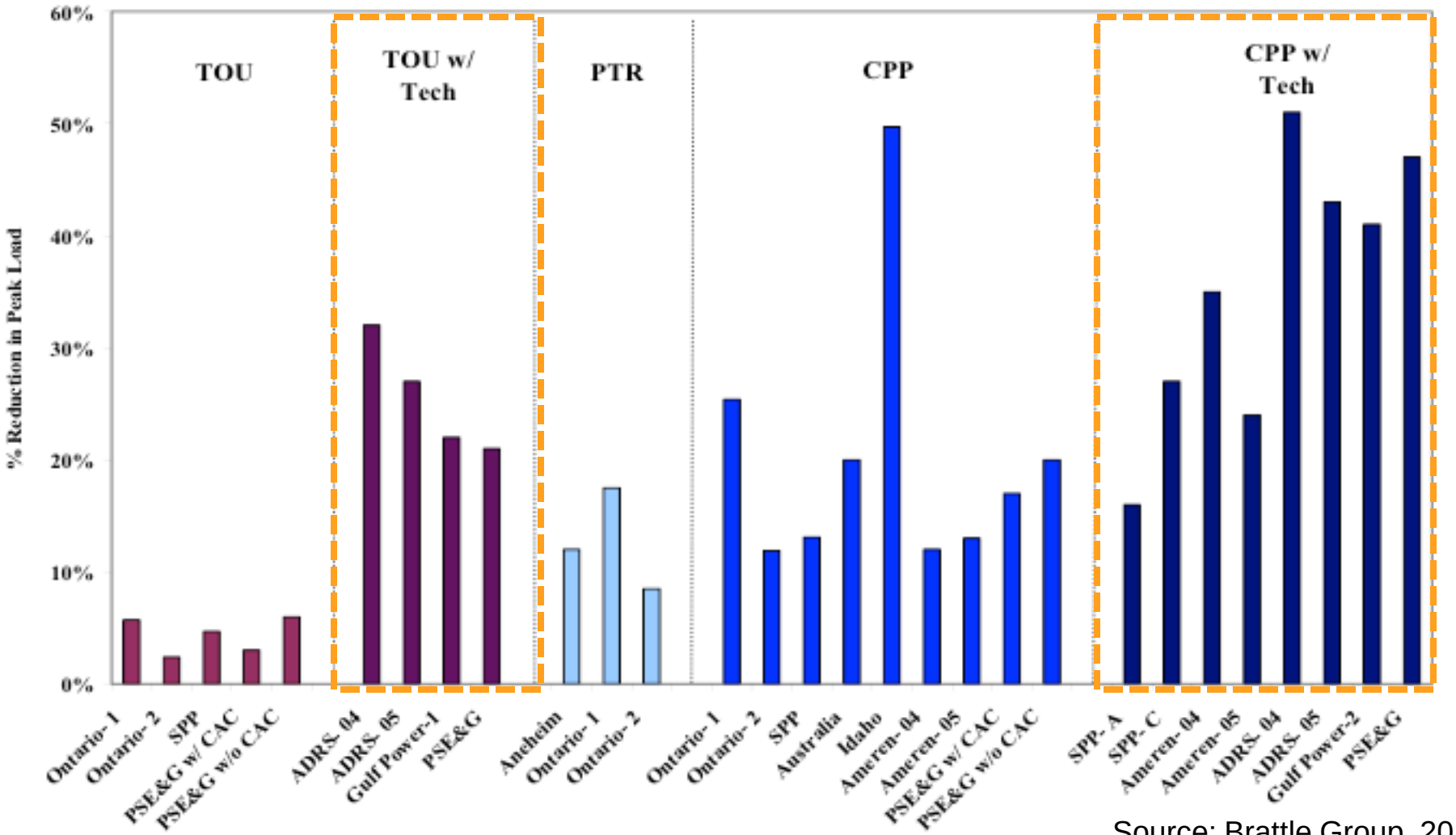

Source: Brattle Group, 2010.